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Title: Attitudes towards risk-stratified breast cancer screening among women in England: a cross-sectional survey

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ABSTRACT

Objectives: Risk-stratification may improve the benefit/harm ratio of breast screening; research on acceptability among potential invitees is necessary to guide implementation. We assessed women's attitudes towards and willingness to undergo risk assessment and stratified screening.

Methods: Women in England aged 40-70 years received summary information about the topic and completed face-to-face computer-assisted interviews. Questions assessed willingness to undergo multifactorial breast cancer risk assessment, more frequent breast screening (if at very high risk) or less frequent or no screening (if at very low risk), and preferences for delivery of assessment results.

Results: Among 933 women, 85% thought breast cancer risk assessment was a good idea; 74% were willing to have it. Among 125 women unwilling to have risk assessment, reasons commonly related to 'worry' (14%) and 'preferring not to know' (14%). Among those willing to have risk assessment (n=689), letters/emails were generally preferred (42%) for results about very low risk status; face-to-face communication was most commonly preferred for results of very high risk status (78%). General Practitioners were most commonly preferred sources of assessment results (≈40%); breast cancer specialists were often preferred for results of very high risk status (38%). 70% thought risk-stratified breast screening was a good idea; 89% were willing to have more frequent screening. Fewer would accept less (51%) or no screening (37%) if at very low risk.

Conclusions: Women were generally in favour of multifactorial breast cancer risk assessment and risk-stratified screening, but some were unwilling to accept less or no screening if at very low risk.

Keywords: Breast Neoplasms; Mass screening; Risk Assessment; Attitude; Surveys and Questionnaires

INTRODUCTION

The Breast Screening Programme in England currently invites all women aged 50 to 70 years for mammography on a triennial basis. However, there is growing interest in whether the balance of harms and benefits of screening could be improved by estimating women's personal risk status and tailoring screening accordingly. For example, the Tyrer-Cuzick model estimates risk of breast cancer based on a range of factors including body mass index, family history, and the results of genetic testing.[1-4] This information could be used to vary screening intervals so that women at higher risk are screened more frequently than triennially (as in the PROCAS study)[3] and women at lower risk are screened less frequently or not at all. This would direct limited resources towards women more likely to benefit from screening (via early detection of cancers) while reducing the opportunity costs and harms (e.g. overdiagnosis) faced by women less likely to benefit.[5]

In order to be successful, risk-stratified breast screening must be acceptable to the target population. The PROCAS study tested uptake of breast cancer risk assessment and screening behaviour following feedback of risk results to those at high risk and found that although uptake of 18-monthly screening was high (99%),[6] uptake of the initial risk assessment itself was relatively low at 37-47%.[3] Women's perceptions of risk assessment and related interventions have been well researched, in general. For example, around 50 qualitative studies have been

conducted and the majority of these have been in the context of primary prevention such as lifestyle changes and risk-reducing medication.[7] However, relatively few have assessed issues relating to risk-stratified screening, specifically. Studies that have report that women's attitudes towards breast cancer risk assessment are generally positive.[8,9] and Meisel et al. (2015) found that women generally consider risk-stratified breast screening to be a good idea and would be willing to have more frequent screening if at high genetic risk. However, markedly fewer women would be willing to have less frequent screening if at lower risk.[10] Comparable findings are reported by Henneman et al. (2011)[9] who found that women endorsed the concept of risk-based breast screening but had concerns about some women not being invited for any screening. However, the perceived acceptability of not being invited for any breast screening (if women were at very low risk) has not been quantified in the general population. Furthermore, previous studies have focused on risk-stratified screening based solely on genetic testing, not multifactorial algorithms that are the more likely method of assessment.[3-4] Women may have more negative overall attitudes towards this (since it requires the disclosure of additional personal information) or positive attitudes (since it may be perceived as offering greater accuracy). There is some support for both hypotheses from a recent qualitative focus group study. In a sample of 52 women in Australia, participants saw advantages of a multifactorial approach but had reservations around data security and motivations behind transitioning to this method.[11]

There is also varied evidence on women's preferences for delivery of risk assessment results. Research from the United States suggests that women have mixed preferences for written (vs. face-to-face) information, and from primary care clinicians and genetic counsellors,[12-13] whereas participants in a study in Sweden found a consultation with a cancer specialist was most preferable.[8] To our knowledge, this has not been assessed in England, which has a different

healthcare system: unlike the United States, the health service in England carries out a mass screening programme. Given that this programme has become well-established over decades, women in England may expect it to be involved in risk-stratified screening.[9] Furthermore, preferences for a delivery method may differ depending on the whether the results indicate high or low risk; this has not been tested previously.

The present study addresses these gaps in the literature using a large population-representative survey of women at or approaching the current age of eligibility for breast screening in England.

Research aims

Full research aims are stated on Open Science Framework (OSF; https://osf.io/fg7qj/). We aimed to determine:

- The extent to which women think it would be a good or bad idea to use a range of risk factors in order to estimate breast cancer risk.
- The extent to which women would be willing or unwilling to have their risk of breast cancer estimated using multifactorial algorithms, and women's reasons for being willing or unwilling to have their risk estimated in this way.
- Women's preferences for receiving their results if they were found to be i) at very low risk or ii) at very high risk of breast cancer.
- The extent to which women think it would be a good or bad idea to vary the frequency of breast screening based on this form of risk assessment using multifactorial algorithms.

- The extent to which women would be willing or unwilling to have i) more frequent screening; ii) less frequent screening; iii) no screening based on their risk status.

We also carried out an exploratory analysis of participant characteristics (e.g. age and frequency of worry about breast cancer) potentially associated with i) willingness to have breast cancer risk assessment, ii) willingness to have less frequent breast screening (if at very low risk), and acceptability of the NHS only inviting women at higher risk for screening (if at very low risk).

METHODS

Design

Data were collected by a survey company (Kantar TNS) between 25th January and 12th February 2019. Questions for this study were embedded within a larger weekly survey on unrelated topics, administered to participants face-to-face in their homes with the assistance of a computer. Households are approached within small geographic areas selected based on stratified random location sampling, using the Postcode Address File and 2011 Census. Within each area, population representativeness is increased using quotas based on age, gender, employment status, and children living within a household.

Consenting participants read summary information about breast cancer, screening, risk assessment and risk-stratification (Figure 1) immediately prior to completing survey questions. Participants were debriefed on where to find further information on breast cancer and screening from the NHS. Institutional ethical approval was obtained (registration number: 2951/007). The study was pre-registered on OSF.

Figure 1 – Summary information on breast cancer and screening

Background information

- In the UK, 15 out of 100 women are diagnosed with breast cancer over their lifetime. Four out of 100 women in the UK die of breast cancer.
- The NHS in England currently offers routine **breast screening** every three years to all women aged 50 to 70 years. Screening aims to save lives from breast cancer by diagnosing it earlier when it is easier to treat.
- Although there are benefits to screening all women aged 50 to 70 years, there are also some risks. For example, some women will be diagnosed and treated for breast cancer that would have never otherwise been found and would not have become life-threatening (for example, because it is growing very slowly). Some women will also experience unnecessary worry or distress because they receive an abnormal screening result that turns out to not be breast cancer.
- Scientists are starting to work out how to identify women who are at very high or very low risk of developing breast cancer. They are doing this using information such as age, family history, reproductive history, lifestyle factors, weight, and results from genetic testing.
- It may be possible to make breast screening more efficient by using this information so that women who are at very high risk of developing breast cancer are offered more frequent routine breast screening, making it more likely that their cancers are detected earlier.
- It may also be possible to offer less frequent routine breast screening to women who are at very low risk of developing breast cancer, or not offering them any routine breast screening, so that they do not face the risks of screening when they are less likely to benefit from it.

Participants

Participants were women in England, aged 40 to 70 years (i.e. approaching or at the age of eligibility for being invited to the existing Breast Screening Programme)[14] and excluded if they did not self-report that they had not been diagnosed with breast cancer.

Measures

Demographic characteristics:

In addition to questions on age and sex, participants were asked to report their ethnicity, marital status, education (graduate level or above, or other qualifications; the latter category included A Levels, apprenticeships, and technical or vocational qualifications), and employment status (working or not working; the latter category included participants who were retired and were either looking or not looking for work) and employment type. Data on National Readership Survey occupational social grade were also collected (Grade A to E; Grades A and E denoted highest (managerial/professional) and lowest (semi-skilled/unskilled) grades, respectively. Grades were determined by the survey company based on factors relating to the occupation of the Chief Income Earner in the household). Data on additional background characteristics were collected as part of the broader survey but are not reported here.

Breast cancer and screening:

Participants were asked about their perceived susceptibility to breast cancer (relative to other women their age) and how often they worried about getting breast cancer, based on previously used measures[15-16]. Participants were also asked whether any family members had been diagnosed with breast cancer, and whether they had ever had a mammogram (for any reason). If they reported having had a mammogram and were eligible for breast screening based on their age (i.e. were 47 to 70 years), they were asked if this had been part of screening.

Attitudes towards risk assessment and preferences for receiving results:

Participants were asked what they thought *"of the idea of using information like age, family history, reproductive history, lifestyle factors, weight, and results from genetic testing to identify women who are at very high or very low risk of developing breast cancer"* (*"very bad idea"*, *"bad idea"*, *"good idea"*, *"very good idea"*, *"not sure"*, *"prefer not to say"*). Participants were also asked if they would *"personally be willing to have your risk of breast cancer estimated using this*

kind of information, if the NHS were to offer it?" (*"yes, definitely"*, *"yes, probably"*, *"no, probably not"*, *"no, definitely not"*, *"not sure"*, *"prefer not to say"*).

Participants were then given a free-text field to state their reasons for being (un-)willing to have breast cancer risk assessment, as applicable. Willing participants were asked i) how (e.g. *"face-to-face"*, *"by telephone"*) and ii) from whom (e.g. *"my General Practitioner (GP)"*, *"a screening practitioner from a hospital"*) they would prefer to receive risk assessment results if they were at i) very low risk and ii) very high risk.

Attitudes towards risk-stratified screening:

Participants were asked their thoughts on *"the idea of varying how often women are invited for breast screening based on them being at very high or very low risk of developing breast cancer"* (responses as before) and whether they would *"personally be willing to have [their] breast screening invitations…"* i) more often than every three years if at very high risk and ii) less often than every three years if at very low risk. Finally, participants were asked whether (if they were at very low risk) it would be acceptable for the NHS Breast Screening Programme to only invite women at higher risk than themselves for breast screening (response options were as above).

The survey was designed with input from two patient representatives. Questions are included on OSF.

Analysis

Free-text data were coded using content analysis by the survey company once all data were collected, prior to transfer to the research team. Responses were assigned to a category when content was mentioned by at least three participants; category names were derived on the basis of responses rather than a pre-defined coding frame. A subsample of 50 responses was

evaluated by a member of the research team (AG) to confirm codes were appropriate. Descriptive statistics report proportions of participants giving each possible response to questions and 95% confidence intervals.

Exploratory binomial logistic regression models tested whether participant characteristics were associated with three dependent variables (willingness to have breast cancer risk assessment, willingness to have less frequent breast screening, and acceptability of the NHS not inviting women for screening, if at low risk) dichotomised into *"yes, definitely" / "yes probably"* vs. *"no, definitely not" / "no, probably not"* / *"not sure"*. Independent variables were age (categorised into groups; 40-49, 50-59 vs. 60-70 years), ethnicity (White British vs. other ethnic groups), marital status (married / living as married, widowed / divorced/separated vs. single), highest level of education (graduate level / above vs. other qualifications / not sure), social grade (Grade A or B, grade C1, grade C2 vs. grade D or E), perceived susceptibility to breast cancer (*"a little higher"* / *"much higher"*, *"about the same"*, *"not sure"* vs. *"much lower"* / *"a little lower"*), frequency of worry about breast cancer (*"often"* / *"very often"* / *"occasionally"* / *"sometimes"*, *"not sure"* vs. *"never"*), family history of breast cancer (*"yes"* vs. *"no"* / *"not sure"*), personal experience of (any) mammography (*"yes"* vs. *"no"* / *"not sure"*). Variables were dummy coded and tested for multicollinearity; all Variance Inflation Factors <10. Bonferroni corrections based on the number of variables in each model were applied to adjust for multiple comparisons. Sensitivity analyses repeated analyses with responses of *"not sure"* excluded from dependent variables.

Analyses were conducted in SPSS version 25; raw data and syntax files are available on OSF.

RESULTS

Participant characteristics

1,135 participants began the survey; 936 met the inclusion criteria and 3 participants were excluded for responding *"prefer not to say"* for all questions. Mean age was 54.9 years (standard deviation: 9.3). Demographic characteristics and responses to questions on breast cancer and screening experience are in Table 1. Kantar TNS do not collect information on numbers of people approached for the omnibus survey so we are unable to report a true response rate.

Attitudes towards risk assessment and preferences for delivering results

Proportions of participants in each response category for questions on breast cancer risk assessment are in Table 2. A large majority considered it a good idea (85%) and stated they would definitely/probably take up an offer (74%). The most common reasons for being willing were labelled *"(early) detection/(early) treatment"* (11%), *"family history"* (9%), and *"so you know/would want to know"* (8%). The three most common reasons for being unwilling were *"too much of a worry/I wouldn't want to worry"* (14%), *"I would rather not know"* (14%), and *"I have already been tested/I already know my risk"* (7%). All categories of reasons for being (un-)willing are in the Appendix.

Preferences for methods of delivering risk assessment results are in Table 3. Face-to-face communication was preferred for delivering assessment results on very high risk status by most participants (78%) followed by letters/emails (12%); the most commonly preferred people to deliver these results were GPs (45%) or breast cancer specialists (38%). Where assessment results indicated very low risk, letters/emails were the most commonly preferred method of delivery (42%), followed by face-to-face communication (37%); GPs (40%) and nurses at GP surgeries (19%) were the most commonly preferred people to deliver this result.

Attitudes towards risk-stratified screening

Table 4 shows proportions of participants giving each response to questions about risk-stratified breast screening. Most participants thought it was a good idea (70%) and a large majority stated they would be willing to have more frequent screening if at very high risk (89%). 51% of participants stated that they were willing to have less frequent screening if at very low risk, and 37% would find it acceptable if the NHS did not invite women at very low risk.

Factors associated with willingness to have breast cancer risk assessment, less frequent breast screening, and acceptability of the NHS not inviting women at lower risk

In the models testing factors potentially associated with dependent variables of interest, there was only weak evidence against the null hypothesis for all but one included variable after adjusting for multiple comparisons. For worry about breast cancer, those who ever worried were more likely (OR: 1.89; p=.031) and those who were not sure were less likely (OR: 0.27; p=.019) to be willing to have risk assessment compared with participants who never worried about breast cancer (overall p=.002; adjusted-α=.0056; next smallest p-value=.013). This possible association was not observed in the sensitivity analysis (excluding *"not sure"* responses from dependent variables; p=.022), reducing confidence in this finding. Sensitivity analysis results were not otherwise appreciably different to main results. Full results of all models are reported in the Appendix.

Table 1 – Sample characteristics

Measures	Total (N=933)	%	95% confidence interval
Age groups			
40-49 years	297	31.8	28.9 to 34.9
50-59 years	299	32.0	29.1 to 35.1
60-70 years	337	36.1	33.1 to 39.2
Ethnicity			
White British	767	82.2	79.7 to 84.6
Other groups	158	16.9	14.6 to 19.4
Refused	8	0.9	0.4 to 1.6
Marital status			
Married/Living as a couple	560	60.0	56.9 to 63.1
Widowed/Divorced/Separated	196	21.0	18.5 to 23.7
Single	177	19.0	16.6 to 21.6
Highest level of education			
Graduate level/Above	287	30.8	27.9 to 33.8
Other qualifications	624	66.9	63.8 to 69.8
Not sure	12	1.3	0.7 to 2.2
Prefer not to say	10	1.1	0.6 to 1.9
Social grade			
Grade A or B (highest social grade)	182	19.5	17.1 to 22.1
Grade C1	230	24.7	22.0 to 27.5
Grade C2	193	20.7	18.2 to 23.4
Grade D or E (lowest social grade)	328	35.2	32.1 to 38.3
Employment status			
Working	483	51.8	48.6 to 55.0
Not working	450	48.2	45.0 to 51.4
Area type			
Urban	743	79.6	77.0 to 82.1
Rural	190	20.4	17.9 to 23.0
Perceived susceptibility to breast cancer (relative to other women their age)			
Much higher/A little higher	129	13.8	11.7 to 16.2
About the same	403	43.2	40.0 to 46.4
A little lower/Much lower	221	23.7	21.0 to 26.5
Not sure	150	16.1	13.8 to 18.5
Prefer not to say	30	3.2	2.2 to 4.5
Frequency of worry about breast cancer			
Very often/Often/Sometimes/Occasionally	545	58.4	55.2 to 61.5
Never	330	35.4	32.4 to 38.5
Not sure	35	3.8	2.7 to 5.1
Prefer not to say	23	2.5	1.6 to 3.6
Family history of breast cancer			
Yes	218	23.4	20.7 to 26.2
No	669	71.7	68.7 to 74.5
Not sure	29	3.1	2.1 to 4.4
Prefer not to say	17	1.8	1.1 to 2.8
Personal experience of mammography (for any reason)			
Yes	610	65.4	62.3 to 68.4
No	294	31.5	28.6 to 34.5
Not sure	12	1.3	0.7 to 2.2
Prefer not to say	17	1.8	1.1 to 2.8
Personal experience of screening mammography (screening-eligible women who had undergone mammography)			
Yes	501	88.8	86.0 to 91.2
No	55	9.8	7.5 to 12.4
Not sure	7	1.2	0.6 to 2.4
Prefer not to say	1	0.2	0.02 to 0.8

Table 2 – Attitudes towards and willingness to have breast cancer risk assessment

Measures	Total (N=933)	%	95% confidence interval
Attitudes towards breast cancer risk assessment			
Very good idea	350	37.5	34.4 to 40.7
Good idea	446	47.8	44.6 to 51.0
Bad idea	17	1.8	1.1 to 2.8
Very bad idea	14	1.5	0.9 to 2.4
Not sure	77	8.3	6.6 to 10.1
Prefer not to say	29	3.1	2.1 to 4.4
Willingness to have breast cancer risk assessment			
Yes, definitely	372	39.9	36.8 to 43.0
Yes, probably	317	34.0	31.0 to 37.1
No, probably not	77	8.3	6.6 to 10.1
No, definitely not	48	5.1	3.9 to 6.7
Not sure	89	9.5	7.8 to 11.5
Prefer not to say	30	3.2	2.2 to 4.5

Table 3 – Preferred methods of receiving risk assessment results by risk status

Preferred methods of receiving assessment results	Total* (N=689)	%	95% confidence interval
If very low risk…			
Modality…			
Face-to-face	253	36.7	33.2 to 40.4
By a letter or email	288	41.8	38.2 to 45.5
By telephone	64	9.3	7.3 to 11.6
No preference	104	15.1	12.6 to 17.9
Not sure	12	1.7	1.0 to 2.9
Prefer not to say	5	0.7	0.3 to 1.6
Information source…			
My general practitioner (GP)	276	40.1	36.4 to 43.8
A nurse from my GP surgery	133	19.3	16.5 to 22.4
A breast cancer specialist from a hospital	95	13.8	11.4 to 16.5
A genetic counsellor from a hospital	28	4.1	2.8 to 5.7
A screening practitioner from a hospital	71	10.3	8.2 to 12.7
The screening programme	92	13.4	11.0 to 16.0
No preference	179	26.0	22.8 to 29.3
Not sure	11	1.6	0.9 to 2.7
Prefer not to say	9	1.3	0.6 to 2.4
If very high risk…			
Modality…			
Face-to-face	537	77.9	74.7 to 80.9
By a letter or email	79	11.5	9.2 to 14.0
By telephone	43	6.2	4.6 to 8.2
No preference	41	6.0	4.4 to 7.9
Not sure	10	1.5	0.7 to 2.6
Prefer not to say	5	0.7	0.3 to 1.6
Information source…			
My general practitioner (GP)	310	45.0	41.3 to 48.7
A nurse from my GP surgery	81	11.8	9.5 to 14.3
A breast cancer specialist from a hospital	262	38.0	34.5 to 41.7
A genetic counsellor from a hospital	59	8.6	6.6 to 10.8
A screening practitioner from a hospital	77	11.2	9.0 to 13.7
The screening programme	44	6.4	4.7 to 8.4
No preference	77	11.2	9.0 to 13.7
Not sure	9	1.3	0.6 to 2.4
Prefer not to say	6	0.9	0.4 to 1.8

*Participants could state more than one response

Table 4 – Attitudes towards and willingness to have risk-stratified breast screening

Measures	Total (N=933)	%	95% confidence interval
Attitudes towards risk-stratified breast screening			
Very good idea	183	19.6	17.2 to 22.3
Good idea	473	50.7	47.5 to 53.9
Bad idea	82	8.8	7.1 to 10.7
Very bad idea	36	3.9	2.8 to 5.2
Not sure	129	13.8	11.7 to 16.2
Prefer not to say	30	3.2	2.2 to 4.5
Willingness to have more frequent breast screening (if at very high risk)			
Yes, definitely	666	71.4	68.4 to 74.2
Yes, probably	168	18.0	15.6 to 20.6
No, probably not	15	1.6	0.9 to 2.6
No, definitely not	12	1.3	0.7 to 2.2
Not sure	39	4.2	3.0 to 5.6
Prefer not to say	33	3.5	2.5 to 4.9
Willingness to have less frequent breast screening (if at very low risk)			
Yes, definitely	226	24.2	21.6 to 27.0
Yes, probably	252	27.0	24.2 to 29.9
No, probably not	203	21.8	19.2 to 24.5
No, definitely not	151	16.2	13.9 to 18.7
Not sure	67	7.2	5.7 to 9.0
Prefer not to say	34	3.6	2.6 to 5.0
Acceptability of the NHS not inviting women at lower risk			
Yes, definitely	124	13.3	11.2 to 15.6
Yes, probably	217	23.3	20.6 to 26.0
No, probably not	195	20.9	18.4 to 23.6
No, definitely not	286	30.7	27.8 to 33.7
Not sure	77	8.3	6.6 to 10.1
Prefer not to say	34	3.6	2.6 to 5.0

DISCUSSION

This study found that the vast majority of participants (85%) had positive attitudes towards breast cancer risk assessment based on multiple risk factors including genetic factors, a finding consistent with previous studies in which similarly large majorities endorsed other forms of risk assessment for ovarian and breast cancer[17-18] and a range of female cancers that also included cervical and endometrial cancer.[19] Similar findings to Wegwarth et al. (2019)[19] were also observed for the most common reasons for favouring risk assessment, which often centred on early detection/treatment, family history, and wanting to know personal risk. This provides some evidence that breast cancer risk assessment would be received favourably if offered to the general population. However, it is notable that uptake in the PROCAS study was 37-47%, based on a real offer of one form of breast cancer risk assessment, suggesting that caution may be needed when drawing implications from our study about likely uptake rates.[3] Our study found that among the 15% who were unwilling to have risk assessment themselves, reasons given most frequently related to worry and preferring not to know. These may represent the predominant barriers that require mitigating in order to maximise uptake among those disinclined to undergo risk assessment. In addition, there may be other important barriers among those with positive attitudes that prevent them from participating when faced with a real offer.

This large-scale quantitative study adds to previous research comprised mainly of qualitative studies with relatively small sample sizes or population-based surveys carried out in other countries where healthcare systems and public attitudes may differ. This study also distinguished between levels of risk when assessing preferences for how assessment results would be relayed to participants: Previous results from Sweden showed that a consultation was the most popular method of receiving risk assessment results.[8] However, this study found that letters and emails were the most commonly preferred method for results of very low risk status but face-to-face communication was preferred for results of very high risk, indicating that more personal follow-up would be preferred if results have more significant health implications. In addition, GPs (and practice nurses) were the most commonly preferred healthcare professionals for providing results, although hospital-based breast cancer specialists were preferred almost as often as GPs for delivering results of very high risk status. The Breast Screening Programme itself was preferred only rarely. In the England, primary care only has limited involvement with breast screening and there would be significant challenges in developing an

organisational model for a large scale breast cancer risk assessment and feedback programme in which primary care took a more prominent role, given its finite capacity, especially if tailored around women's preferences for face-to-face feedback. However, these findings suggest that this would be perceived positively by participants. Alternatives to primary care include family history clinics, which are run by specialists in hereditary disease who can offer risk assessment, counselling, and referral for further investigation. However, participants were not asked to state their preferences for these since they were less likely to be familiar with them.

As in Meisel et al. (2015),[10] most women (70%) stated that risk-stratified screening was a good idea; somewhat lower than the equivalent percentage for risk assessment. In addition, participants' reasons for being willing to have a risk assessment indicated that assessment was perceived as having a wide range of advantages unrelated to risk-stratified screening. An overwhelming majority of participants (89%) were willing to have more frequent screening if they were at very high risk, which was consistent with both hypothetical intentions and actual behaviour in previous studies.[3,10] We also found that only around a third of women (37%) stated that not being invited for any screening would be acceptable if at very low risk. Although somewhat lower than the 51% of women who were willing to accept less frequent screening, it might be considered encouraging that as many as 1 in 3 women would be willing to forego any screening at all (if at very low risk). However, it is notable that 31% of participants stated they would *"definitely not"* accept no screening, providing an indication that any resistance would be likely to be intense (as well as widespread) if it were adopted as screening policy.

This study has limitations. We aimed to make information on the multifactorial nature of risk assessment clear and prominent (e.g. by restating it within survey questions) but we did not test participants' knowledge of this element directly, meaning that we cannot confirm that participants factored it into their responses. Similarly, practical constraints in the amount of information that participants could be expected to absorb meant that the risk labels of *"very low"* and *"very high"* were left open to interpretation and few details were provided on some complicated concepts (e.g. overdiagnosis). Participants may have responded differently if they had received and understood more information on this or other topics.[20,21] Responses were also elicited in a hypothetical context and may have differed following a real invitation. As previously noted, uptake was lower in the PROCAS study.[3] Finally, it is possible that associations with acceptability were missed in the

exploratory analyses due to small numbers. For example, we found some evidence of a plausible association in which women who worried about breast cancer were more likely to be willing to have risk assessment than women who did not worry, but this was not supported in other models or sensitivity analyses. In addition, older women (60-70 years) may have been less likely to be willing to have risk assessment than women aged 40-50 years. However, confidence intervals were often wide and most p-values provided only weak evidence against the null hypothesis after adjusting for multiple comparisons.

This study indicates several areas for further research. We elicited attitudes relating to risk assessment and screening for breast cancer only: these may differ for other types of cancer. A previous online survey found that 72% of women wanted to know their 10-year risk of breast cancer vs. only 65% for endometrial cancer[19] and qualitative findings suggest that some women may be more accepting of longer intervals for cervical than breast screening.[11] This could be tested in future studies. We also assessed perceptions of one type of risk assessment (multifactorial); future studies could test for differences in perceptions based on the type of risk assessment described. For example, participants could be allocated at random to receive information on either multifactorial or genetics-only risk assessment, and compared on outcomes such as willingness to take up a hypothetical invitation.

Conclusions

This study reports a number of findings relevant to the development of risk-stratified breast screening. Encouragingly, women were generally in favour of risk assessment and (more frequent) risk-stratified screening. However, it may be necessary to address the most common barriers to risk assessment among unwilling participants in order to increase uptake. These include worry and preferring not to know risk status. Several findings may be relevant guides to implementing large-scale risk assessment and risk-stratified screening: Letters/emails were most commonly preferred methods for receiving results of very low risk status whereas face-to-face communication was preferred for results of very high risk status. GPs were the preferred sources of information relating to risk status. However, participants were relatively unwilling to accept less frequent and especially no breast screening following assessment results of very low risk status. Future research can be used to better understand and mitigate this resistance.

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REFERENCES

1. Tyrer, J, Duffy, SW, Cuzick, J. A breast cancer prediction model incorporating familial and personal risk factors. Stat Med 2004; 23: 1111-30.
2. Amir, E, Evans, DG, Shenton, A. Evaluation of breast cancer risk assessment packages in the family history evaluation and screening programme. J Med Genet 2003; 40: 807-814.
3. Evans, DG, Astley, S, Stavrinos, P. Improvement in risk prediction, early detection and prevention of breast cancer in the NHS Breast Screening Programme and family history clinics: a dual cohort study. Programme Grants for Applied Research 2016; 4.
4. Evans, DGR, Harkness, EF, Brentnall, AR. Breast cancer pathology and stage are better predicted by risk stratification models that include mammographic density and common genetic variants. Breast Cancer Res Treat 2019; 176: 141-148.
5. Pashayan, N, Morris, S, Gilbert, FJ. Cost-effectiveness and benefit-to-harm ratio of risk-stratified screening for breast cancer: a life-table model. JAMA Oncol 2018; 4: 1504-1510.

6. French, DP, Southworth, J, Howell, A. Psychological impact of providing women with personalised 10-year breast cancer risk estimates. Br J Cancer 2018; 118: 1648-1657.
7. Rainey, L, van der Waal, D, Wengström, Y. Women's perceptions of personalised risk-based breast cancer screening and primary prevention: a systematic review. Acta Oncol 2018; 57: 1275-1283.
8. Koitsalu, M, Sprangers, MA, Eklund, M. Public interest in and acceptability of the prospect of risk-stratified screening for breast and prostate cancer. Acta Oncol 2016; 55: 45-51.
9. Henneman, L, Timmermans, DR, Bouwman, CM. 'A low risk is still a risk': exploring women' attitudes towards genetic testing for breast cancer susceptibility in order to target disease prevention. Public Health Genomics 2011; 14: 238-247.
10. Meisel, SF, Pashayan, N, Rahman, B. Adjusting the frequency of mammography screening on the basis of genetic risk: attitudes among women in the UK. Breast 2015; 24: 237-241.
11. Lippey, J, Keogh, LA, Mann, GB. "A natural progression": Australian women's attitudes about an individualized breast screening model. Cancer Prev Res 2019; 12: 383-390.
12. Amornsiripanitch, N, Mangano, M, Niell, BL. Screening mammography: patient perceptions and preferences regarding communication of estimated breast cancer risk. AJR Am J Roentgenol 2017; 208: 1163-1170.
13. Flores, KG, Steffen, LE, McLouth, CJ. Factors associated with interest in gene-panel testing and risk communication preferences in women from BRCA1/2 negative families. J Genet Couns 2017; 26: 480-490.
14. National Health Service. Overview. Breast cancer screening. https://www.nhs.uk/conditions/breast-cancer-screening (2018, accessed 20 June 2019).
15. Vernon, SW. Risk perception and risk communication for cancer screening behaviors: a review. J Natl Cancer Inst Monogr 1999; 25: 101-119.
16. National Cancer Institute. Health information national trends survey, https://hints.cancer.gov (2017, accessed 20 June 2019).
17. Meisel, SF, Rahman, B, Side, L. Genetic testing and personalized ovarian cancer screening: a survey of public attitudes. BMC Womens Health 2016; 16: 46.

18. Fisher, BA, Wilkinson, L, Valencia, A. Women's interest in personal breast cancer risk assessment and lifestyle advice at NHS mammography screening. J Public Health 2017; 39: 113-121.
19. Wegwarth, O, Pashayan, N, Widschendter, M. Women's perception, attitudes, and intended behaviour towards predictive epigenetic risk testing for female cancers in 5 European countries: a cross-sectional online survey. BMC Public Health 2019; 19: 667.
20. Wegwarth, O, Gigerenzer, G. Less is more: Overdiagnosis and overtreatment: evaluation of what physicians tell their patients about screening harms. JAMA Intern Med 2013; 172: 2086-2087.
21. Hersch, J, Barratt, A, Jansen, J. Use of decision aid including information on overdetection to support informed choice about breast cancer screening: a randomised controlled trial. Lancet 2015; 385: 1642-1652.

APPENDIX

Reasons for being willing to undergo breast cancer risk assessment

	Total* (N=689)	%	95% confidence interval
Reason			
(Early) detection/(early) treatment	75	10.9	8.7 to 13.4
Family history	59	8.6	6.6 to 10.8
So you know/would want to know	56	8.1	6.3 to 10.3
Good/good idea	44	6.4	4.7 to 8.4
Prevention is better than cure/prevention	32	4.6	3.3 to 6.4
Information/to be informed	31	4.5	3.1 to 6.2
To know my risk level	28	4.1	2.8 to 5.7
Reassurance/peace of mind	28	4.1	2.8 to 5.7
Helpful/might/will help (no detail)	20	2.9	1.8 to 4.4
Might/will help others	19	2.8	1.7 to 4.2
Check/to check/be checked	16	2.3	1.4 to 3.7
For research	14	2.0	1.2 to 3.3
Could save your life/saves lives/don't want to die	12	1.7	1.0 to 2.9
Sensible/sensible idea	12	1.7	1.0 to 2.9
Awareness/so you are aware	10	1.5	0.7 to 2.6
To be prepared	10	1.5	0.7 to 2.6
I am high risk/have previously had cancer	9	1.3	0.6 to 2.4
For my family/children	8	1.2	0.6 to 2.2
Important/it's important	7	1.0	0.5 to 2.0
To be safe	7	1.0	0.5 to 2.0
Protection/reduce risk	7	1.0	0.5 to 2.0
To look after my health	8	1.2	0.6 to 2.2
I know people who have suffered with cancer	8	1.2	0.6 to 2.2
Should have regular checks	7	1.0	0.5 to 2.0
To be sure	5	0.7	0.3 to 1.6
It's more accurate/more thorough	4	0.6	0.2 to 1.4
Might/will help me	3	0.4	0.1 to 1.2
Curious/curiosity	2	0.3	0.1 to 0.9
Nothing	54	7.8	6.0 to 10.0
Other answers	34	4.9	3.5 to 6.7
Don't know	67	9.7	7.7 to 12.1
Prefer not to say	37	5.4	3.9 to 7.2

*Participants could state more than one response

Reasons for being unwilling to undergo breast cancer risk assessment

	Total* (N=125)	%	95% confidence interval
Reason			
Too much of a worry/I wouldn't want the worry	17	13.6	8.4 to 20.4
I would rather not know	17	13.6	8.4 to 20.4
I have already been tested/I already know my risk	9	7.2	3.6 to 12.7
I am low risk/no family history	8	6.4	3.1 to 11.7
I look after my own health	6	4.8	2.0 to 9.6
It is not 100% accurate	4	3.2	1.1 to 7.4
You can't control/can't change the outcome	4	3.2	1.1 to 7.4
Testing methods are not/equipment is not safe	2	1.6	0.3 to 5.0
The testing methods are painful/uncomfortable	2	1.6	0.3 to 5.0
It can/will affect (health) insurance	2	1.6	0.3 to 5.0
Everyone should be checked/treated the same	3	2.4	0.7 to 6.3
I don't want to	7	5.6	2.5 to 10.7
Nothing	13	10.4	6.0 to 16.6
Other answers	11	8.8	4.8 to 14.7
Don’t know	10	8.0	4.2 to 13.7
Prefer not to say	12	9.6	5.4 to 15.7

*Participants could state more than one response

Full results of the binomial logistic regression model testing for variables associated with willingness to have breast cancer risk assessment

			Yes, definitely; yes, probably (vs. No, definitely not; no, probably not; not sure)		
Characteristic	**Total (n=871)**	**Yes, definitely; yes, probably (n=669; 76.8%)**	**Unadjusted OR, 95% CI**	**Adjusted OR, 95% CI**	**p-value***
Age groups					Overall: .036
60-70 years	307	227 (73.9)	0.79, 0.54 to 1.15	0.51, 0.30 to 0.86	.011
50-59 years	279	219 (78.5)	1.02, 0.68 to 1.52	0.72, 0.44 to 1.17	.178
vs. 40-49 years	285	223 (78.2)			
Ethnicity					
White British	728	573 (78.7)	1.81, 1.22 to 2.68	1.48, 0.96 to 2.28	.074
vs. Other groups	143	96 (67.1)			
Marital status					Overall: .162
Married/Living as a couple	529	404 (76.4)	1.18, 0.79 to 1.77	1.01, 0.65 to 1.56	.970
Widowed/Divorced/Separated	185	150 (81.1)	1.57, 0.94 to 2.61	1.56, 0.89 to 2.71	.118
vs. Single	157	115 (73.2)			
Highest level of education					
Graduate level/Above	274	219 (79.9)	1.30, 0.92 to 1.85	0.96, 0.62 to 1.47	.838
vs. Other qualifications/Not sure	597	450 (75.4)			
Social grade					Overall: .478
Grade A or B	174	140 (80.5)	1.67, 1.07 to 2.63	1.39, 0.80 to 2.40	.238
Grade C1	212	170 (80.2)	1.65, 1.08 to 2.50	1.34, 0.85 to 2.13	.213
Grade C2	184	145 (78.8)	1.51, 0.98 to 2.33	1.34, 0.84 to 2.13	.222
vs. Grade D or E	301	214 (71.4)			
Perceived susceptibility					Overall: .026
A little higher/Much higher	126	110 (87.3)	1.97, 1.06 to 3.65	1.32, 0.67 to 2.59	.423
About the same	395	312 (79.0)	1.08, 0.72 to 1.62	0.86, 0.56 to 1.32	.483
Not sure	139	83 (59.7)	0.43, 0.27 to 0.68	0.53, 0.32 to 0.88	.013
vs. Much lower/A little lower	211	164 (77.7)			
Worry					Overall: **.002**
Very often/Often/ Occasionally/Sometimes	530	436 (82.3)	1.89, 1.36 to 2.63	1.49, 1.04 to 2.15	.031
Not sure	30	12 (40.0)	0.27, 0.13 to 0.59	0.38, 0.17 to 0.86	.019
vs. Never	311	221 (71.1)			
Family history					
Yes	211	173 (82.0)	1.51, 1.02 to 2.23	1.11, 0.72 to 1.73	.630
vs. No/Not sure	660	496 (75.2)			
Personal experience of mammography					
Yes	585	462 (79.0)	1.43, 1.03 to 1.99	1.61, 1.04 to 2.50	.034
vs. No/Not sure	286	207 (72.4)			

*A Bonferroni correction based on the number of variables in the model indicates an adjusted-α of .0056 (.05/9)

Full results of the binomial logistic regression model testing for variables associated with willingness to have less frequent breast screening (if at very low risk)

			Yes, definitely; yes, probably (vs. No, definitely not; no, probably not; not sure)		
Characteristic	**Total (n=869)**	**Yes, definitely; yes, probably (n=464; 53.4%)**	**Unadjusted OR, 95% CI**	**Adjusted OR, 95% CI**	**p-value***
Age groups					Overall: .348
60-70 years	304	151 (49.7)	0.76, 0.55 to 1.05	0.76, 0.50 to 1.16	.211
50-59 years	280	152 (54.3)	0.92, 0.66 to 1.28	0.95, 0.64 to 1.41	.808
vs. 40-49 years	285	161 (56.5)			
Ethnicity					
White British	724	384 (53.0)	0.92, 0.64 to 1.31	1.04, 0.71 to 1.52	.860
vs. Other groups	145	80 (55.2)			
Marital status					Overall: .167
Married/Living as a couple	528	271 (51.3)	0.68, 0.47 to 0.97	0.71, 0.48 to 1.03	.074
Widowed/Divorced/Separated	185	98 (53.0)	0.72, 0.47 to 1.11	0.86, 0.54 to 1.35	.505
vs. Single	156	95 (60.9)			
Highest level of education					
Graduate level/Above	273	139 (50.9)	0.87, 0.65 to 1.15	1.05 0.74 to 1.48	.789
vs. Other qualifications/Not sure	596	325 (54.5)			
Social grade					Overall: .024
Grade A or B	174	79 (45.4)	0.60, 0.41 to 0.88	0.62, 0.40 to 0.97	.035
Grade C1	209	101 (48.3)	0.68, 0.48 to 0.97	0.68, 0.46 to 0.99	.045
Grade C2	184	109 (59.2)	1.06, 0.73 to 1.53	1.11, 0.75 to 1.64	.595
vs. Grade D or E	302	175 (57.9)			
Perceived susceptibility					Overall: .790
A little higher/Much higher	125	60 (48.0)	0.68, 0.44 to 1.06	0.79, 0.48 to 1.31	.360
About the same	392	209 (53.3)	0.84, 0.60 to 1.18	0.87, 0.61 to 1.25	.450
Not sure	140	73 (52.1)	0.80, 0.52 to 1.23	0.85, 0.54 to 1.34	.480
vs. Much lower/A little lower	212	122 (57.5)			
Worry					Overall: .087
Very often/Often/ Occasionally/Sometimes	528	273 (51.7)	0.77, 0.58 to 1.03	0.88, 0.65 to 1.20	.426
Not sure	31	11 (35.5)	0.40, 0.18 to 0.86	0.41, 0.19 to 0.92	.030
vs. Never	310	180 (58.1)			
Family history					
Yes	212	102 (48.1)	0.76, 0.55 to 1.03	0.78, 0.55 to 1.10	.159
vs. No/Not sure	657	362 (55.1)			
Personal experience of mammography					
Yes	580	298 (51.4)	0.78, 0.59 to 1.04	0.90, 0.63 to 1.30	.579
vs. No/Not sure	289	166 (57.4)			

*A Bonferroni correction based on the number of variables in the model indicates an adjusted-α of .0056 (.05/9)

Full results of the binomial logistic regression model testing for variables associated with acceptability of the NHS not inviting women at lower risk women for screening

			Yes, definitely; yes, probably (vs. No, definitely not; no, probably not; not sure)		
Characteristic	**Total (n=868)**	**Yes, definitely; yes, probably (n=325; 37.4%)**	**Unadjusted OR, 95% CI**	**Adjusted OR, 95% CI**	**p-value***
Age groups					Overall: .426
60-70 years	304	105 (34.5)	0.75, 0.54 to 1.05	0.76, 0.49 to 1.18	.221
50-59 years	281	103 (36.7)	0.82, 0.59 to 1.15	0.92, 0.61 to 1.37	.670
vs. 40-49 years	283	117 (41.3)			
Ethnicity					
White British	723	274 (37.9)	1.13, 0.78 to 1.63	1.37, 0.91 to 2.05	.129
vs. Other groups	145	51 (35.2)			
Marital status					Overall: .132
Married/Living as a couple	528	184 (34.8)	0.71, 0.50 to 1.03	0.82, 0.56 to 1.21	.318
Widowed/Divorced/Separated	186	75 (40.3)	0.90, 0.58 to 1.39	1.19, 0.74 to 1.90	.467
vs. Single	154	66 (42.9)			
Highest level of education					
Graduate level/Above	274	96 (35.0)	0.86, 0.64 to 1.16	0.93, 0.65 to 1.33	.708
vs. Other qualifications/Not sure	594	229 (38.6)			
Social grade					Overall: .064
Grade A or B	174	58 (33.3)	0.64, 0.43 to 0.94	0.69, 0.43 to 1.10	.118
Grade C1	209	67 (32.1)	0.60, 0.42 to 0.87	0.58, 0.39 to 0.87	.008
Grade C2	184	68 (37.0)	0.75, 0.52 to 1.09	0.76, 0.51 to 1.13	.178
vs. Grade D or E	301	132 (43.9)			
Perceived susceptibility					Overall: .013
A little higher/Much higher	125	42 (33.6)	0.56, 0.36 to 0.89	0.60, 0.36 to 1.01	.055
About the same	392	136 (34.7)	0.59, 0.42 to 0.83	0.56, 0.39 to 0.81	.002
Not sure	140	47 (33.6)	0.56, 0.36 to 0.87	0.57, 0.35 to 0.91	.019
vs. Much lower/A little lower	211	100 (47.4)			
Worry					Overall: .034
Very often/Often/ Occasionally/Sometimes	529	186 (35.2)	0.70, 0.53 to 0.94	0.85, 0.62 to 1.17	.317
Not sure	31	5 (16.1)	0.25, 0.09 to 0.67	0.27, 0.10 to 0.75	.012
vs. Never	308	134 (43.5)			
Family history					
Yes	213	71 (33.3)	0.79, 0.57 to 1.09	0.84, 0.58 to 1.21	.344
vs. No/Not sure	655	254 (38.8)			
Personal experience of mammography					
Yes	582	199 (34.2)	0.66, 0.49 to 0.88	0.68, 0.47 to 1.00	.048
vs. No/Not sure	286	126 (44.1)			

*A Bonferroni correction based on the number of variables in the model indicates an adjusted-α of .0056 (.05/9)

Sensitivity analysis 1 - Full results of the binomial logistic regression model testing for variables associated with willingness to have breast cancer risk assessment (with *"not sure"* excluded from the dependent variable)

			Yes, definitely; yes, probably (vs. No, definitely not; no, probably not; not sure)		
Characteristic	**Total (n=787)**	**Yes, definitely; yes, probably (n=669; 85.0%)**	**Unadjusted OR, 95% CI**	**Adjusted OR, 95% CI**	**p-value***
Age groups					Overall: .094
60-70 years	277	227 (81.9)	0.71, 0.45 to 1.14	0.52, 0.28 to 0.98	.044
50-59 years	252	219 (86.9)	1.04, 0.63 to 1.74	0.80, 0.44 to 1.46	.466
vs. 40-49 years	258	223 (86.4)			
Ethnicity					
White British	663	573 (86.4)	1.86, 1.15 to 2.99	1.65, 0.98 to 2.75	.058
vs. Other groups	124	96 (77.4)			
Marital status					Overall: .801
Married/Living as a couple	474	404 (85.2)	1.15, 0.69 to 1.93	1.03, 0.60 to 1.77	.922
Widowed/Divorced/Separated	175	150 (85.7)	1.20, 0.65 to 2.22	1.21, 0.63 to 2.34	.563
vs. Single	138	115 (83.3)			
Highest level of education					
Graduate level/Above	251	219 (87.3)	1.31, 0.85 to 2.02	1.07, 0.63 to 1.82	.794
vs. Other qualifications/Not sure	536	450 (84.0)			
Social grade					Overall: .969
Grade A or B	160	140 (87.5)	1.51, 0.85 to 2.65	1.12, 0.57 to 2.21	.746
Grade C1	198	170 (85.9)	1.31, 0.78 to 2.18	1.00, 0.57 to 1.74	.986
Grade C2	169	145 (85.8)	1.30, 0.76 to 2.22	1.11, 0.63 to 1.97	.711
vs. Grade D or E	260	214 (82.3)			
Perceived susceptibility					Overall: .476
A little higher/Much higher	122	110 (90.2)	1.79, 0.88 to 3.62	1.15, 0.53 to 2.50	.730
About the same	359	312 (86.9)	1.30, 0.80 to 2.11	0.96, 0.57 to 1.62	.891
Not sure	110	83 (75.5)	0.60, 0.34 to 1.07	0.65, 0.35 to 1.23	.188
vs. Much lower/A little lower	196	164 (83.7)			
Worry					Overall: .022
Very often/Often/ Occasionally/Sometimes	489	436 (89.2)	2.23, 1.49 to 3.34	1.85, 1.19 to 2.87	.007
Not sure	17	12 (70.6)	0.65, 0.22 to 1.92	0.91, 0.29 to 2.92	.879
vs. Never	281	221 (78.6)			
Family history					
Yes	196	173 (88.3)	1.44, 0.89 to 2.35	1.13, 0.66 to 1.94	.651
vs. No/Not sure	591	496 (83.9)			
Personal experience of mammography					
Yes	538	462 (85.9)	1.23, 0.82 to 1.86	1.47, 0.85 to 2.53	.164
vs. No/Not sure	249	207 (83.1)			

*A Bonferroni correction based on the number of variables in the model indicates an adjusted-α of .0056 (.05/9)

Sensitivity analysis 2 - Full results of the binomial logistic regression model testing for variables associated with willingness to have less frequent breast screening (if at very low risk; with *"not sure"* excluded from the dependent variable)

			Yes, definitely; yes, probably (vs. No, definitely not; no, probably not; not sure)		
Characteristic	**Total (n=806)**	**Yes, definitely; yes, probably (n=464; 57.6%)**	**Unadjusted OR, 95% CI**	**Adjusted OR, 95% CI**	**p-value***
Age groups					Overall: .321
60-70 years	288	151 (52.4)	0.65, 0.46 to 0.92	0.74, 0.48 to 1.16	.193
50-59 years	262	152 (58.0)	0.82, 0.57 to 1.16	0.94, 0.62 to 1.43	.768
vs. 40-49 years	256	161 (62.9)			
Ethnicity					
White British	676	384 (56.8)	0.82, 0.56 to 1.21	1.00, 0.66 to 1.51	.997
vs. Other groups	130	80 (61.5)			
Marital status					Overall: .259
Married/Living as a couple	484	271 (56.0)	0.66, 0.45 to 0.97	0.71, 0.47 to 1.07	.101
Widowed/Divorced/Separated	178	98 (55.1)	0.63, 0.40 to 1.00	0.78, 0.48 to 1.27	.319
vs. Single	144	95 (66.0)			
Highest level of education					
Graduate level/Above	257	139 (54.1)	0.81, 0.60 to 1.09	0.99, 0.69 to 1.43	.971
vs. Other qualifications/Not sure	549	325 (59.2)			
Social grade					Overall: .015
Grade A or B	162	79 (48.8)	0.54, 0.37 to 0.81	0.60, 0.37 to 0.95	.031
Grade C1	198	101 (51.1)	0.60, 0.41 to 0.86	0.62, 0.42 to 0.93	.021
Grade C2	171	109 (63.7)	1.01, 0.68 to 1.49	1.09, 0.72 to 1.65	.689
vs. Grade D or E	275	175 (63.6)			
Perceived susceptibility					Overall: .849
A little higher/Much higher	120	60 (50.0)	0.65, 0.41 to 1.02	0.80, 0.48 to 1.34	.398
About the same	365	209 (57.3)	0.87, 0.61 to 1.23	0.94, 0.64 to 1.36	.731
Not sure	120	73 (60.8)	1.01, 0.63 to 1.60	0.94, 0.64 to 1.36	.936
vs. Much lower/A little lower	201	122 (60.7)			
Worry					Overall: .285
Very often/Often/ Occasionally/Sometimes	499	273 (54.7)	0.71, 0.52 to 0.95	0.82, 0.59 to 1.14	.231
Not sure	22	11 (50.0)	0.58, 0.24 to 1.39	0.56, 0.22 to 1.42	.224
vs. Never	285	180 (63.2)			
Family history					
Yes	198	102 (51.5)	0.72, 0.52 to 1.00	0.78 0.54 to 1.12	.176
vs. No/Not sure	608	362 (59.5)			
Personal experience of mammography					
Yes	554	298 (53.8)	0.60, 0.44 to 0.82	0.73, 0.49 to 1.08	.112
vs. No/Not sure	252	166 (65.9)			

*A Bonferroni correction based on the number of variables in the model indicates an adjusted-α of .0056 (.05/9)

Sensitivity analysis 3 - Full results of the binomial logistic regression model testing for variables associated with acceptability of the NHS only inviting higher risk women for screening (if at very low risk; with "*not sure*" excluded from the dependent variable)

			Yes, definitely; yes, probably (vs. No, definitely not; no, probably not; not sure)		
Characteristic	**Total (n=797)**	**Yes, definitely; yes, probably (n=325; 40.8%)**	**Unadjusted OR, 95% CI**	**Adjusted OR, 95% CI**	**p-value***
Age groups					Overall: .361
60-70 years	285	105 (36.8)	0.67, 0.47 to 0.94	0.73, 0.46 to 1.16	.181
50-59 years	261	103 (39.5)	0.75, 0.53 to 1.06	0.90, 0.58 to 1.37	.613
vs. 40-49 years	251	117 (46.6)			
Ethnicity					
White British	671	274 (40.8)	1.02, 0.69 to 1.50	1.31, 0.86 to 1.99	.211
vs. Other groups	126	51 (40.5)			
Marital status					Overall: .139
Married/Living as a couple	486	184 (37.9)	0.65, 0.44 to 0.95	0.77, 0.51 to 1.15	.200
Widowed/Divorced/Separated	175	75 (42.9)	0.80, 0.51 to 1.25	1.09, 0.67 to 1.77	.733
vs. Single	136	66 (48.5)			
Highest level of education					
Graduate level/Above	259	96 (37.1)	0.80, 0.59 to 1.08	0.87, 0.60 to 1.27	.478
vs. Other qualifications/Not sure	538	229 (42.6)			
Social grade					Overall: .042
Grade A or B	164	58 (35.4)	0.56, 0.38 to 0.84	0.66, 0.41 to 1.06	.085
Grade C1	192	67 (34.9)	0.55, 0.38 to 0.81	0.55, 0.37 to 0.84	.005
Grade C2	173	68 (39.3)	0.67, 0.45 to 0.98	0.69, 0.46 to 1.05	.083
vs. Grade D or E	268	132 (49.3)			
Perceived susceptibility					Overall: .025
A little higher/Much higher	117	42 (35.9)	0.55, 0.34 to 0.88	0.63, 0.37 to 1.07	.085
About the same	363	136 (37.5)	0.59, 0.41 to 0.83	0.57, 0.39 to 0.83	.003
Not sure	119	47 (39.5)	0.64, 0.40 to 1.02	0.58, 0.35 to 0.96	.033
vs. Much lower/A little lower	198	100 (50.5)			
Worry					Overall: .268
Very often/ often/ Occasionally/Sometimes	500	186 (37.2)	0.65, 0.48 to 0.87	0.79, 0.57 to 1.10	.156
Not sure	17	5 (29.4)	0.45, 0.16 to 1.32	0.57, 0.18 to 1.78	.334
vs. Never	280	134 (47.9)			
Family history					
Yes	197	71 (36.0)	0.77, 0.55 to 1.07	0.82, 0.56 to 1.20	.316
vs. No/Not sure	600	254 (42.3)			
Personal experience of mammography					
Yes	549	199 (36.2)	0.55, 0.41 to 0.75	0.61, 0.41 to 0.91	.015
vs. No/Not sure	248	126 (50.8)			

*A Bonferroni correction based on the number of variables in the model indicates an adjusted-α of .0056 (.05/9)